that a continuity of the protoplasm between adjacent cells occurs in *Dionæa muscipula*, being especially pronounced in the most central layers of parenchymatous cells.

The parenchyma cells of the petioles of certain plants which, as H. von Mohl showed, are often thick walled and conspicuously pitted, afforded favourable material for investigation. In *Aucuba japonica*, and *Prunus lauro-cerasus*, distinct threads could be made out crossing the pit-closing membrane. In *Ilex aquifolium* there was a doubtful striation, and in the rest examined a mere coloration of the pit-membrane.

Examples of continuity have thus been shown to exist in ordinary parenchymatous tissue; and this materially strengthens the belief that the phenomenon of the connexion of cells with one another is one of universal occurrence.

As to the function of the filaments, the author believes that in sieve-tubes and in endosperm-cells they may make possible a transference of solid materials, besides establishing a protoplasmic communication; but in ordinary cells the only significance of the threads is, that by their means the protoplasm of isolated cells becomes connected, and that thus the communication of impulses from one part of the plant to another is insured.

Finally, the presence of these minute perforations of the cell-wall need not lead to any modification of our general ideas as to the mechanics of the cell.

V. "Note on the Constitution of Chlorophyll." By Edward Schunck, F.R.S. Received December 6, 1883.

An examination of some products derived from chlorophyll, which has occupied me for some time, has led to the question of the true nature and constitution of chlorophyll, a question on which widely different opinions prevail. Without entering into matters which concern the physiologist only, it may be said that to the chemist chlorophyll is simply an organic colouring-matter, the substance to which the green colour of leaves and other parts of plants is due. Now colouring-matters are of three kinds. To the first class belong such as occur ready formed and in a free state in vegetable and animal organisms, such as the colouring-matters of turmeric and safflower. The second class comprises those that are formed from colourless chromogens by the combined action of alkalis and oxygen, the colouring-matters of log-wood and archil being well-known examples of this class. These colouring-matters change rapidly when exposed to the further action of oxygen in the presence of alkali, but are quite

stable when in contact with acids. The third class consists of glucosides, bodies which do not undergo any considerable change under the influence of alkalis, but are rapidly decomposed when acted on by acids or ferments, yielding, on the one hand, some kind of glucose, and, on the other, substances in which the tinctorial properties of the parent substance are much more pronounced. To this division belong the colouring-matters of madder, quercitron, cochineal, &c. Now chlorophyll in its general properties so much resembles the members of the last class that one cannot help suspecting that to this class it may belong—that it is in fact a glucoside. It shows considerable stability in the presence of alkalis, but acids decompose it rapidly, giving rise to substances which are intensely coloured and show a power of absorbing particular parts of the spectrum much more strongly than chlorophyll itself. Whether, along with the latter bodies, it yields by decomposition with acids some kind of glucose, seemed to me a question worthy of attention.

If it was possible to obtain chlorophyll in a state of purity, it would be very easy to settle this question; unfortunately all attempts hitherto made to separate and purify chlorophyll have ended in its decomposition. I consider it as certain that the so-called crystallised chlorophyll which has been described by several authors is in fact a derivative of chlorophyll formed during the process employed for preparing it. It is, however, very easy to obtain a solution of chlorophyll which shall be quite free from everything soluble in water extracted at the same time from the plant, and therefore free from ready-formed glucose. In order to effect this, I proceed as follows:—Having extracted leaves of any kind with boiling alcohol, I allow the extract to stand for some time, filter off the deposit which usually forms, and then mix it with its own volume of ether and with about two volumes of water, shaking up well. The liquid now separates into two layers, an upper green one, containing all the chlorophyll of the extract, and a lower bright yellow one, which contains tannin, a yellow colouring-matter, a substance giving the glucose reaction with Fehling's solution, and probably other substances besides. The two liquids are separated in the usual way, and the upper one is shaken up with fresh water, which now usually only shows a trace of colour. This process of washing may be repeated, adding each time a little fresh ether, until the lower layer ceases to give the glucose reaction. The upper liquid leaves on spontaneous evaporation a bright green residue, which, though far from being pure chlorophyll, is free from everything soluble in water, and may therefore be employed to determine whether anything soluble in water, such as glucose, is formed by the action of acids on it. If some of the residue be treated with concentrated sulphuric acid in the cold it dissolves, forming a green solution, which, after standing for some time, gives,

on the addition of water, a dark green precipitate. This precipitate consists essentially of two substances, the phyllocyanin and phylloxanthin of Frémy, which are undoubtedly products derived from chlorophyll, showing the absorption bands of what is usually called "acid chlorophyll." The liquid filtered from this precipitate, when mixed with copper sulphate and an excess of caustic alkali, becomes blue, and the mixture, on boiling, deposits cuprous oxide. The experiment may be made in a slightly different manner. The residue left by the green ethereal solution of chlorophyll having been dissolved in alcohol, sulphuric or hydrochloric acid is added to the solution, which is then boiled for some time, evaporated so far as to drive off most of the alcohol, filtered from the products insoluble in water, made alkaline, then mixed with Fehling's solution and boiled, when the usual glucose reaction takes place. In order to make sure that the reaction was not due to ready-formed glucose, I took in every case the precaution of testing a portion of the green chlorophyllic residue with Fehling's solution before acting on the rest with acid. This was easily done by treating with weak alcohol, to which a little alcoholic potash and some Fehling's solution were added, and heating, when the whole dissolved easily, giving a green solution, which, on boiling, in no case deposited the least trace of cuprous oxide, whereas, after adding an excess of hydrochloric acid to the liquid, boiling, filtering off the insoluble products, again making alkaline and boiling, the glucose reaction took place in a marked manner.

This experiment has never in any case failed, and it would follow, if uniformly successful, that the green leaves of all plants contain a glucoside insoluble in water, but soluble in alcohol and ether. That this glucoside is, in fact, chlorophyll seems to me highly probable. Nevertheless, absolute certainty cannot be attained, because the matter experimented on is a mixture, and it is possible that one plant out of many might give a decidedly negative result, which would upset the conclusion drawn from the rest. Assuming, however, that the phenomena will always occur as above described, and that the reaction with Fehling's solution indicates the presence of some kind of glucose, it would follow either that chlorophyll is a glucoside, or that it is always accompanied in the vegetable cell by a glucoside of very similar properties.

I may add that I attempted to isolate the glucose or glucose-like substance formed under the circumstances described, spinach leaves being the material employed, and obtained a pale yellow gum-like substance which showed no tendency to assume a crystalline form.